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PSYCHOLOGICAL ASPECTS OF CAMOUFLAGE DESIGN AND DETECTION: STRESS AND VISUAL INFORMATION PROCESSING

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16. ABSTRACT

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In the case of a search of a large, complex field, automatic processing of information may lead to the selection of likely target areas, however controlled search processes may be required to scan the information in an automatically selected array.

Attentional capacity is required in a controlled search task. The effect of stress is an effective reduction in the available attentional capacity. Thus it is predicted that the effects of stress on a visual search/detection task should be:

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ABSTRACT (CONT'D)

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b. apart from "a", automatic detection operations should be unaffected by stress;

c. that controlled processing aspects of a detection task should be adversely affected by observer stress.

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CONTENTS

INTRODUCTION

1. The task of detecting a concealed target in the field involves the interaction of two sets of variables: those related to object characteristics and those related to observer characteristics. This literature survey will briefly review object characteristics which may affect the probability of detection and will then concentrate upon those observer characteristics which may be important.

2. The discussion of observer characteristics will treat with increasing emphasis the following aspects:

a. (A. Physical Aspects). The physical properties and limitations of the human optical system;

b. (B. Visual Information Processing). The cognitive psychological aspects of the task involved, relating the search and detection processes to the practical task of detection of human targets in the field;

c. (C. Psychological and Physiological). Additional psychological factors which may affect the performance of the observer - these factors may be characterised as Stress.

3. This report is part of a project whose aims are to investigate:

a. target features which may affect detection;

b. observer variables, including the effect of acute environmental stress on a visual detection task.

OBJECT CHARACTERISTICS

4. Overington (1976) has reviewed many of the factors relating to the visual acquisition of targets. Among the object attributes which may affect the probability of detection are:

/a. Size.

a. Size.

b. Contrast (whether positive, negative in luminance; texture contrast; colour contrast).

c. Edge sharpness.

d. Motion.

e. Object orientation and shape.

5. In the case of a man concealed in the field, it may be better to eliminate motion as a factor for the purposes of this study. Although human motion has been reported to be distinctive and recognisable (Johansson, 1977), any motion would be likely to draw the attention of the observer to the region of the motion and detection would be likely to follow. Taken together, the other variables may be summarized as indicating that if there is any degree of discontinuity between the target and the background of the viewed scene then detection may occur if:

a. attention is directed to the target; and

b. there is a match between the shape of the perceived discontinuity(including extrapolation, or "completion" to identify partly concealed targets) and any of a (learned) range of possible target shapes.

The cognitive processes involved in the directing of attention towards a target, and the recognition of a target will be discussed below (see Visual Information Processing).

OBSERVER CHARACTERISTICS

A. Physical Aspects of Human Vision.

6. Since the eye consists of very few, quite simple optical components, it is reasonable to expect that the quality of the retinal image will be less than "perfect". Aberrations increase as the pupil size increases (and pupil diameter is controlled by a combination of factors which include prevailing light conditions, and endocrine activity). It is conventional to assume that under good conditions the eye can resolve stimuli separated by 0.15 mrad (Overington, 1976), however resolution is a function of contrast and for low

levels of contrast and relatively low luminance levels, threshold angular size may be as great as 10 mrad. This range corresponds to a man standing at approximately 10 km from the observer (0.15 mrad) to a man standing 200 m from the observer (10 mrad).

7. Visual acuity is best when an image is focussed upon the fovea - the central cluster of cones in the retina. This area provides the facility for critical vision and is usually classified as an area of up to 20 mrad (approximately 1°) subtense. Images falling outside this area will be progressively poorly processed with respect to detail, although this decrease in performance is considerably less in the case of detection of motion. In visual detection tasks, the demands of the task can interact with the performance of the visual system: for example in a low attention demanding task it has been shown that essentially foveal levels of discrimination are possible over a visual angle of 30°, however when the attentional demands of the task are increased (by adding to the quantity of distracting information, or "visual noise") then the functional foveal field is found to contract to approximately 1° (Mackworth, 1976).

8. Visual acuity tends to decrease as pupil size increases, as noted above. To change the pupil diameter is one means by which the eye can accommodate to differences in the luminance of the scene, however the action of the pupil is not that simple. The pupil can only vary the transmitted light by a ratio in the order of 30:1, whereas the eye can adapt to a range of luminance over a range of 10^7:1. The pupil actually sets itself to a diameter where it is able to cope with the most likely sudden changes in scene luminance; in addition to being determined by overall luminance levels, the pupil size is also affected by physiological and psychological factors (Nunnally, Knott, Duchnowski and Parker, 1967). Therefore, under field conditions, it may be reasonable to expect that due to a combination of varying luminance conditions and the liklihood of arousal levels of the observer affecting pupil size, the probable setting of pupil aperture may not be optimum in terms of obtaining maximum visual acuity in the region of the target.

/9. The adaptation

9. The adaptation of the eye to different levels of luminance takes a distinct amount of time, and if the state of adaption is other than matched to the target field luminance, then performance of the visual system is degraded according to the degree of mismatch between field luminance and adaptation state. This effect of luminance adaptation may be important in the case of a search for concealed human targets in the field. If the target is hidden in an area of different luminance than the general field (for example in a shadow) then the observer's task will be rendered more difficult as the target region will not represent a match in luminance and observer adaptation state.

B. Visual Information Processing.

10. In regarding scenes and pictures, the eyes dart about rapidly from one location to another, and some objects are fixated more often than others (Gould, 1976). The fixation patterns vary depending upon search instructions given to the observer - and this indicates that the strategies governing the fixation patterns are to some extent under the voluntary control of the viewer (Gould, 1976). In the absence of a governing search strategy, an automatic process selects the successive fixation points (Shiffrin and Schneider, 1977). This automatic process may favour complex or "interesting" areas of the display rather than uniform areas, or with training the fixation points may favour likely target positions rather than locations where experience has taught that targets are never located (Shiffrin and Schneider, 1977). In the field, these results may suggest that attention will be directed upon irregularities (such as bushes in an open field), and this tendency to focus upon likely areas may be improved by experience.

11. Fixation times in visual searches are typically in the order of 200 to 300 ms, with better trained (and more successful) searcher tending to make more frequent, shorter duration fixations (Gould, 1976). However as visual information overload is increased (by an increase of visual noise) the searcher responds by an effective narrowing of the functional fovea and by an increase in fixation time (to approximately 450 ms) in an attempt to cope with the increase in information available in a single fixation (Mackworth, 1976).

/Controlled

Controlled Search and Automatic Detection

12. To provide a model which explains the empirical findings of visual search investigations, Shiffrin and Schneider (1977) have proposed a theory of information processing based upon two fundamental processing modes : controlled search, and automatic detection. Controlled search is highly demanding of attentional capacity, is usually serial in nature with a limited comparison rate, is easily established by the subject, and is strongly dependent on load.

13. Automatic detection refers to relatively well learned targets stored in long term memory, is demanding of attention only when a target is detected, is parallel in nature, is difficult to ignore or to suppress once learned, and is virtually unaffected by load. Automatic detection can be employed in the case of a search for any member of a well learned category (for example, parts of a man or his infantry equipment). Furthermore, studies have shown that automatic encoding of arbitrary collections of characters can develop after prolonged training: for a relatively demanding and unfamiliar task, in the order of 1500 trials may be necessary to establish automatic detection (Shriffin and Schneider, 1977). Evidence from the field supports the need for experience in target detection: it is reported that during the Vietnam conflict "a pilot's ability to detect camouflaged targets improved during the first four to ten weeks of operational experience ..." (Lintern, 1974, p 3).

14. Treisman and Gelade (1980) have investigated the conditions under which either automatic detection or controlled serial search processes need to be invoked for the successful identification of a target. It is proposed that a visual scene may be initially encoded as a set of features along a number of separable dimensions. The term dimension refers to a complete range of variation (such as colour, orientation, or shape), whilst feature refers to a particular value on a dimension (khaki, upright,

/man-shaped)

man-shaped). Note that perceptual dimensions do not necessarily correspond directly to distinct physical dimensions.

15. Focal attention integrates the separable features into unitary objects, and once they have been correctly registered the compound objects continue to be perceived and stored as such. Without focussed attention, features cannot be correctly related to each other and conjunctions of features can be formed on a random basis: illusory conjunctions of features may be formed. This explanation contrasts with what we consciously perceive: "top-down" processing (the Gestalt belief that we initially register unitary objects and relationships, and only later analyze these into their component parts) may be what we consciously experience, however a considerable weight of experimental evidence supports the feature-integration theory of visual information processing. Top-down processing can effectively occur when in a familiar context, and when focussed attention is prevented (for example by brief exposure or overloading). Under these circumstances likely objects can be predicted, and their presence can be checked by matching their disjunctive features with those in the display. In the highly redundant and familiar environments in which we normally operate, this should seldom lead us astray; however when the environment is less predictable or the task requires conjunctions of features to be specified, we are typically less efficient. Examples of this are discussed under "Threshold Stimuli".

16. In summary, the theory of feature integration states that individual features can be detected prior to the directing of attention upon the target. The correct identification and location of a target usually involves a conjunction of features relating to several dimensions: these operations are demanding of attentional capacity and their completion may follow the detection process by a finite time, expecially in the case of identification

/(the distinction

(the distinction between friend from foe, in the case of military targets) where a cognitively difficult conjunction of a number of features is required.

17. In the case of a visual search task where the target can be detected by a single feature, the search for such targets should be little affected by variations in the number of distractors in the display. For example, any of a number of "man" shapes should be detectable by an automatic parallel search process without any demand upon attention. Lateral interference, acuity limits, and discriminability should be the only factors tending to increase search times as display size is increased, perhaps forcing serial eye fixations.

Fixation Patterns and Information Processing

18. In the case of large display sets, visual acuity may vary across the display for a given fixation point, and eye movements may therefore be necessary to bring subsets of the display successively into the effective foveal region.

> "However serial fixations do not imply serial decisions about each item ... serial fixations will be made when the discriminations require foveal acuity, either because they are below threshold with peripheral vision or because there is some form of lateral interference which increases towards the periphery. However within each successive fixation it is at least logically possible that the whole display receives parallel processing, the foveal areas receiving the most detailed sensory information, but all or many stimuli being checked simultaneously." (Treisman and Gelade, p 112).

The influence of unattended, peripheral features on the selection of successive fixation points has also been noted: "the more nearly alike a particular stimulus object is to the one that a person is looking for,

/the more

the more likely it is that the person will foveally fixate that object" (Gould, 1976, p 323).

Threshold Stimuli

19. In the case of threshold stimuli and situations where the total amount of information received is insufficient for a confident decision (for example because of brief exposure) a serial comparison process should be necessary to match the recognised features against the features of the members of the memory set. However in situations when a fast response is required, or when adequate attentional capacity is unavailable, both controlled processing and automatic detection may be operating in parallel and a response may be based upon the features available at a certain point in time, even though a better decision might be available at a later time (Shiffrin and Schneider, 1977).

20. Certain conditions (particularly relating to the psychological state of the observer) may result in a lowered activation threshold. Under these conditions separable features which are detected by the (non-attention demanding) parallel search process can initiate a chain of automatic behavioural responses. This lowering of the activation threshold does not imply that the quality of processing is improved - to the contrary, the automatic responses may be triggered by possible targets rather than by certain targets. Under the stress of combat conditions, inappropriate action may follow the incorrect identification of objects as targets: Pentland (1980) quotes several cases of Australian planes being attacked and shot down by their American allies, apparently because the red in the Australian roundels (red centres, white and blue) were mistaken for the Japanese red rising sun. The incidence of these "false positives" by US fighter pilots became sufficiently common that by 1942 it was decided to eliminate red from the national markings altogether, and by 1943 it was decided to paint the entire tail assemblies of RAAF planes white: a

/further

further effort to reduce the incidence of mistaken identity by US allies. An increase in the incidence of false positives on a digit recognition task under the stress prior to a parachute jump has also been reported (Simonov, 1977).

21. A further example of the occurence of modified threshold levels for specific targets is found in the concept of perceptual vigilance and perceptual defence (Erdelyi, 1974). In the context of the present study, perceptual defence (the effective raising of activation thresholds for specific undesirable stimuli) would not be expected: it would certainly not be adaptive. On the other hand, perceptual vigilance for a relevant target (operationally equivalent to a lowered activation threshold) would be expected - and does indeed occur - in the experienced observer. Under stress, however, the cost of perceptual vigilance may be increased incidence of false positives.

C. Psychological and Physiological Factors

22. Unless automatic detection can occur, then a controlled search process must proceed - and this places a demand upon attentional capacity. Furthermore, when recognition requires additional processing following target detection, attentional capacity is again required. It therefore follows that conditions which interfere with a subject's ability to devote maximum attention capacity to a visual target detection task should interfere with the outcome. Evidence has been reviewed above that under military field conditions, errors of judgement can occur with regard to visual recognition tasks. The factors which can reduce an observer's capacity to cope with an attention-demanding task include:

a. loss of sleep

b. noxious environmental stimuli

c. perceived threat

d. noise and vibration

e. extremes of temperature and humidity

/f. isolation

f. isolation and confinement

g. exercise
(from Cox, 1978)

Each of these conditions has been classified as a "stressor" - that is, they are conditions which can interact with the subject's perception of his situation and produce in the subject the condition of "stress".

The Nature of Stress

23. Selye proposed that stress was a physiological response which did not depend upon the nature of the stressor, and that the response represented a universal pattern of defence reactions. He has recently stated that "The past 30 years of experimentation have led to the current definition of stress as the 'non specific response of the body to any demand'" (Tache and Selye, 1978). This general response (Selye's General Adaptation Syndrome, or GAS) is primarily defined in terms of changes at the pituitary-adrenocortical axis; in the broadest terms, the physiological response of the GAS is an increase in catecholamine levels accompanied and followed by an increase in corticosteriod excretion (Cox, 1978).

24. Although it is usual to refer to endocrine activity as the main parameter by which the stress response is measured, Selye cautions that stress cannot always be equated with this reaction (Tache and Selye, 1978). Other factors can cause either excessive, or suppressed, adrenal activity. Furthermore, confusion can arise over the stereotyped nonspecific character of the stress response: the pattern of endocrine response can be modified depending upon the specific effects of each stressor agent (Tache and Selye, 1978). For example, during exercise the levels of epinephrine and norepinephrine are both elevated, whilst emotional stress tends to raise epinephrine in particular.

25. Mason (1971) attacked the concept of physiological nonspecificity, primarily because of the difficulty in proposing a "primary mediator" with

/appropriate

appropriate efferent pathways whereby the messages due to all nocuous stimuli are conveyed to the neuroendocrine centres. He suggested that the primary mediator underlying the pituitary-adrenal cortical response "may simply be the psychological apparatus involved in emotional arousal reactions to threatening or unpleasant factors in the life situation as a whole." (Mason, 1971, p 329). Selye has concurred that psychological components may play a decisive role in eliciting the typical stress response however he does not agree that stress is a wholly psychologically mediated response. It has been found, for example, that neural differentiation of the hypothalmic region does not prevent the physiological stress responses. Selye proposes that "an effective stressor is an agent perceived psychologically or physiologically" (Tache and Selye, 1978, p 10).

26. With animals, only those responses which are common to all five stressors (exercise, heat, cold, restraint, drugs) are considered to be stress parameters. By comparison with physiological stress, psychological stress is less dependent on the direct impact of the stimuli and more dependent on mediating cognitive factors. For example in the case of employment-related stress, it has been noted that "there is a potential for stress when an environmental situation is perceived as presenting a demand which threatens to exceed the person's capabilities and resources for meeting it ... such that the person is forced to deviate from normal functioning" (Beehr and Newman, 1978, p 668). However, although this tends to emphasize the importance of the cognitive appraisal of the significance of potentially harmful, challenging or threatening events, "stressors of sufficient intensity will induce an acute stress reaction in all so exposed, regardless of predisposition" (Rabkin and Struening, 1976, p 101).

/27. Accepting

27. Accepting that stressors may be psychological as well as physiological leads to the expectation that the nonspecific stress response may include psychological manifestations: "nonspecific behavioural coping mechanisms may also be put into action, such as distracting one's attention from the problem, or orienting one's attention to a secondary problem" (Tache and Selye, 1978, p 19). A review of empirical evidence indicates that stress has a limiting effect on a number of attentional-related capabilities: range of anticipation, use of cues, ability to discriminate objective and subjective aspects of the situation, and the detection of peripheral visual stimuli. An explanation for this effect, developed from a comparison of anxiety patients with normals, is that the combination of stimuli for consideration and stressors can alter the relationship between the two systems for input analysis and preparation for activity; this results in high general arousal, a lack of attentive control, and difficulties in evaluating stimulus meaning (Froehlich, 1978).

28. Given that for successful target recognition in a difficult visual search task, control of focus of attention, use of cues, and detection of peripheral stimuli are all important, it is possible that the incidence of stress in a military field situation may significantly affect an observer's ability to correctly identify targets.

Measurement of Physiological Effects of Stress

29. In many experiments, stress is assumed to be indicated by an increase in the circulating or excreted levels of a selected group of adrenal hormones (for example 19-OHCS, the ketosteroids, or the catecholamines). However, as analytical techniques have improved in their sensitivity, specific differences in the endocrine response have been associated with particular stressors; these findings have led the universal nature of the physiological stress response to be questioned (Mason, 1968). Indeed, Cox (1978) suggests that:

/"the more stimuli

> "the more stimuli studied, the more distinctive the eliciting profile for each component of the physiological response becomes ... the integrative mechanisms controlling the response appear to be organised to react selectively in producing patterns of multi-physiological change which differ according to the specific stimulus" (p 67).

30. However a review of the more recent findings has enabled an alternative interpretation: not that the basis of the GAS is in doubt, but rather that specific stressors can have specific physiological effects in addition to eliciting the GAS responses. Therefore it is important that attention be given to the specific actions of the stressors, as they may interfere or interact with the nonspecific effects: "... a typical parameter may not be modified during a stressful experience if the specific effect of the eliciting agent can inhibit the nonspecific response." (Tache and Selye, 1978, p 12). Having drawn attention to the possible interaction between a stressor and any single index of stress, Selye emphasises the importance of using a number of tests to indicate the physiological effect of a stressor:

> "Because no one parameter can reliably reflect stress either qualitatively or quantitatively, it is necessary to fall back on a battery of tests to measure different indexes in an individual under stress" (Tache and Selye, 1978, p 12).

31. An example of a study which employed a battery of measures to assess the physiological response, and to illustrate the subsequent coping process, is summarised in Table 1. The stressor in this case was primarily psychological (fear or aprehension related to jumps from a parachute training tower), and self-reports tended to confirm the initial presence of stress, and course of the coping process (Ursin, Baade and Levine, 1978).

/Table 1

Table 1

Summary of stress indices, and the effect of the coping process on these indices (Ursin et al, 1978).

indices	method of sampling	effect of first stressor experience	trend on subsequent experiences
cortisol	blood	raised	basal
testosterone	blood	depressed	basal
epinephrine (ug/g creatinin)	urine	raised	basal
norepinephrine (ug/g creatinin)	urine	raised	somewhat raised
fatty acids	blood	raised	basal
growth hormone	blood	raised	somewhat raised
glucose	blood	raised	raised

Psychological effects of stress

32. A consistently reported effect of stress is that performance on tasks which are demanding of attentional capacity tends to be adversely affected when the subject is under stress. This effect is usually interpreted as an effective attentuation of attention capacity, or a disruption of the ability to focus attention upon the task at hand. At this point it may be useful to examine more closely what is meant by attentional capacity, attention, and also the concept of arousal.

33. Attention is the process that leads to the selection of certain stimuli for response, although unattended stimuli can give rise to automatic responses.

/34. Arousal, or

34. Arousal, or activation, refers to some aspects of the waking state, whereas attention refers to some very specific behavioural, congitive, and emotional interactions with the environment. In general arousal is considered to be one of the necessary conditions for attention (to selected stimuli), and there is a prevalent assumption that there is an inverted U-shaped relationship between activation or arousal level and "performance at the level of selectivity", or attention (Froehlich, 1978). At high levels of arousal, attention is believed to be distracted by competing stimuli.

35. Attentional capacity is usually applied to the ability to perform cognitively demanding tasks, and in this sense is a construct similar to "working memory" (Case, 1978). The process of controlled, serial search (comparing each member of one set with each member of another set) is an example of a task demanding of attentional capacity (Shiffrin and Schneider, 1977).

36. The effects of stress upon performance can be explained by either proposing that attentional capacity is diminished in some quantitative sense, or that the ability to focus attention upon the task in hand has been impaired. As neither proposition is exclusive of the other, both effects may occur as a result of exposure to a stressor.

37. The first proposed effect of stress (diminished attentional capacity) may be interpreted as similar to a "cognitive fatigue" condition, and in this context it has been shown that similar reduction in attentional capacity may be induced either by exposure to a stressful situation, or as an aftereffect of a high attentional demanding task (Cohen and Spacapan, 1978). Similarly, the compounded effects of high levels of anxiety (and it is common to associate anxiety with stress-like symptoms) and high memory load lead to impaired performance on logical problem solving tasks -

/again an indication

again an indication that stress corresponds to a decreased attentional capacity (Gross and Mastenbrook, 1980). The depletion of attentional capacity has also been interpreted as the mechanism involved in stress-related deficits on problem-solving tasks (Heuser, 1978; Deffenbacher, 1978).

38. There is also support for the distraction hypothesis: that in some way stress results in an inability to maintain the focus of attention on the appropriate aspects of the task. An early discussion of the inter-relationships between performance, stress and effort (Simon, 1967) provides a psycho-dynamic explanation of the mechanism of the distracting effect of a stressor:

> "when under the effect of some external or internal stress, the ego makes a special effort to deal with that stress, attention cathexis may become directed on to the related automatisms of performance. A paradoxical effect of that effort then ensues ... the deautomatizing influence which consciousness exerts upon established automatisms of the mental apparatus. This process plays a crucial role in both normal and pathological ego functioning." (p 376).

As an example of the relatively structure-breaking function of the ego under conditions of extreme stress, a report is quoted which indicates that in the pressure of battle no more than 25% of men under attack even fire their rifles (Simon, 1967). Similarly, after the battle of Gettysburg, over 200 of the muzzle-loading rifles were found to have been loaded five times or more without being fired (Baddeley, 1972).

39. In a study of the effects of cold (cold water) on higher intellectual tasks (Vaughan, 1977) it was observed that the cold water had a significant deleterious effect after the first hour of exposure, but performance was similar to that of control subjects after the second and third hours.

/Tasks included

Tasks included target detection times, and problem solving exercises. The results of this experiment were interpreted in terms of the distraction hypothesis: "... that extreme and unusual environmental conditions compete with task-relevant stimuli for the attention of the observer, and interfere with his capacity to respond to the task requirements" (Vaughan, 1977, p 104). In this experiment, none of the hormonal indices of stress were monitored and therefore there is no reliable evidence that stress was caused. Furthermore, heart rates tended to drop over the first hour of cold water exposure - and this leads to the interpretation of the results in terms of altered levels of arousal. An earlier report also emphasised the fact that stress is not necessarily caused by emmersion in cold water: it was found that performance decrements do not occur (at least to the same extent) with divers under simulated laboratory conditions when compared with divers involved in open seas diving. However performance deterioration increased subjective anxiety, and increased heart rates were noted in a cold water experiment on novice subjects where the hazards and potential dangers of the experimental conditions were emphasized (Baddeley, 1972).

40. An alternative version of the effect of stress on attention has been proposed: rather than assuming that a distraction of attention occurs, Baddeley (1978) suggests that stress causes a narrowing of focus of the subject's attention to one aspect of the situation, and "if this aspect happens to be the task he is required to perform, then his efficiency will be increased. If not, however, his performance will deteriorate ..." (p 543). However the widespread findings of deterioration of performance under stress tend to weaken this explanation.

41. If a distinction between these two processes (distraction of attention, or reduction of attentional capacity) were required, it may be proposed that the distraction of attention is more associated with high levels of arousal than with the presence of stress - although it should be

/noted that in many

noted that in many cases the level of arousal (often indicated by an increased heart rate) increases with exposure to a stressful situation. On the other hand a reduction in attentional capacity may be more associated with the GAS. The inter-relationship between stress (or anxiety) and arousal is often confused, although from an Adjective Check List (ACL) the two constructs are reported to be orthogonal (Machay, Cox, Burrows and Lazzerini, 1978). Without the application of a suitable battery of physiological measures, experiments involving a mild level "stressor" have therefore reported either improved performance (Jacobs and Kirk, 1969), or conflicting results (Bergstrom 1970 a; Bergstrom 1970 b), or more vigilant behaviour (Averill and Rosenn, 1972). Again, in an investigation of the effects of sleep deprivation (Haslam et al, 1977) some tasks (logical reasoning, controlled search, vigilance) did deteriorate although there was no evidence from endocrine activity that the GAS had been invoked. The interpretation of these experiments involving only mild, non-threatening levels of stress should be interpreted in terms of the inverted U-shaped function of arousal theory.

42. A condition where level of arousal (indicated by heart rate) and a stress response may both occur is in exposure of a subject to high temperature conditions. In a review of the literature, Poulton (1970) suggests that reaction times on simple tasks tend to be faster, but subjects are worse on more complex calculation tasks under acute heat exposure conditions. The faster reaction times are interpreted as due to increased level of arousal, whereas the decreased level of performance on task of higher cognitive demand may be taken as evidence that the effect of stress is to attenuate attentional capacity.

/Summary of Psychological

Summary of Psychological Effects of Stress on Detection Tasks

43. In summary, it is generally acknowledged that increased levels of stress have a deleterious effect on cognitive tasks. However, it is normal to associate augmented stress with raised levels of arousal (particularly when arousal is defined by heart rate, which is usually raised by the additional adrenaline excretion associated with the GAS). Increased arousal tends to have an inverted U relationship with performance, and therefore elevated arousal without stress may lead to improved performance, for example reaction times on simple tasks may be faster. In the case of certain experiments involving a mild level of a stressor, the results may be better interpreted in terms of arousal theory particularly when there is no test for stress (GAS). The difficulties of interpretation of these results would not occur if a battery of stress indices were employed in so-called stress experiments.

44. As an explanation for the diminished performance of stressed subjects, two distinct mechanisms have been proposed:

a. the distraction hypothesis: that the stressor competes for the attention of the subject, and/or he focusses attention on the wrong aspects of the situation;

b. the diminished attentional capacity hypothesis: that the effect of stress is to reduce the capacity of the subject's "working memory".

If the distraction hypothesis were correct, then reaction times as well as performance on higher cognitive tasks would suffer with augmented stress levels, whilst the diminished attentional capacity explanation would predict that only higher cognitive tasks should be affected by raised stress levels. The critical experiments which enable the selection between these theories have been reported on a number of occasions, and the evidence supports the diminished capacity hypothesis.

/45. With regard

45. With regard to the task of detecting a partly concealed target in a military situation, consideration of the above review leads to the prediction that:

a. in a military situation the searcher may be under some level of stress;

b. due to the effects of stress, lower activation threshold levels may lead to an increase in the number of errors;

c. associated with augmented stress, raised arousal levels should lead to faster reaction times on simple tasks - that is, faster reaction to "easy" targets;

d. a "well camouflaged" item should be one which demands attentional capacity of the observer to correctly integrate observable features and lead to a "sighting";

e. because stress tends to diminish attentional capacity, well camouflaged targets should be more difficult to detect under realistic military situations than under more relaxed "experimental" conditions.

FUTURE APPLICATIONS OF THIS STUDY

46. Forthcoming reports associated with this investigation will detail the results of experiments which test the predictions drawn from this review. Specifically, that:

a. the observable aspects of the intellectual process involved in the detection of concealed military-type targets conform to the feature integration model of information processing;

b. environmental stressors can affect performance on a visual search task.

/46. An important

46. An important goal of these investigations is that it should be possible for future camouflage comparisons to design an experimental protocol which is based on an understanding of the psychological functioning of the observer in addition to the well established principles of physical optics. This would directly lead to an increase in both the quality and the quantity of information which can be gained from field trials - and decisions may be made with greater confidence.

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